

IN THE SPECIFICATION

Please delete entirely Page 12, which starts with the header “Brief Description of the Drawings”.

Please replace Paragraph 1, page 26, lines 5-23 with the following amended paragraph:

The individual radicals R_1 of the substituted ethynyl radical on the phenyl ring attached to the adamantane or diamantane ring of the type $R_1C\equiv C-$ are in each case the same or different in Formulae III, IV, V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, and XVI above. R_1 is selected from hydrogen, halogen, alkyl, aryl, substituted aryl, heteroaryl, aryl ether, alkenyl, alkynyl, alkoxy, hydroxyalkyl, hydroxyaryl, hydroxyalkenyl, hydroxyalkynyl, hydroxyl, or carboxyl. Each R_1 may be unbranched or branched and unsubstituted or substituted and the substituents may be unbranched or branched. It is preferred that the radicals alkyl, alkenyl, alkynyl, alkoxy, hydroxyalkyl, hydroxyalkenyl, and hydroxyalkynyl contain from about 2 to about 10 carbon atoms and the radicals aryl, aryl ether, and hydroxyaryl contain from about 6 to about 18 carbon atoms. If R_1 stands for aryl, R_1 is preferably phenyl. Preferably, at least two of the $R_1C\equiv C$ groups on the phenyl groups are two different isomers. Examples of at least two different isomers include *meta*-, *para*-, and *ortho*-isomers. Preferably, the at least two different isomers are *meta*- and *para*-isomers. In the preferred monomer, 1,3,5,7-tetrakis[3'/4'-phenylethynyl]phenyladamantane (~~shown in Figure 1D~~), five isomers form: (1) *para*-, *para*-, *para*-, *para*-; (2) *para*-, *para*-, *para*-, *meta*-; (3) *para*-, *para*-, *meta*-, *meta*-; (4) *para*-, *meta*-, *meta*-, *meta*-; and (5) *meta*-, *meta*-, *meta*-, *meta*-.

Please replace the last paragraph on page 26, lines 25-34, which continues onto page 27, lines 1-8 with the following amended paragraph:

Each Y of the phenyl rings in the Formulae III, IV, V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, and XVI above is in each case the same or different and selected from hydrogen, alkyl, aryl, substituted aryl, or halogen. When Y is aryl, examples of aryl groups include phenyl or biphenyl. Y is selected from preferably hydrogen, phenyl, and biphenyl and more preferably hydrogen. Preferably, at least one of the phenyl groups between two bridgehead carbons of adamantane or diamantane exists as at least two different isomers. Examples of at least two different isomers include *meta*-, *para*-, and *ortho*- isomers. Preferably, the at least two isomers are *meta*- and *para*- isomers. In the most preferred dimer 1,3/4-bis{1',3',5'-tris[3''/4''-(phenylethynyl)phenyl]adamant-7'-yl}benzene (~~shown in Figure 1F~~), 14 isomers form as follows. Preferably, the phenyl group located between the two bridgehead carbons of the adamantane exists as *meta*- and *para*- isomers. For each of the two preceding isomers, seven isomers of the $R_1C\equiv C$ groups on the phenyl groups exist as follows: (1) *para*-, *para*-, *para*-, *para*-, *para*-, *para*-; (2) *para*-, *para*-, *para*-, *para*-, *para*-, *meta*-; (3) *para*-, *para*-, *para*-, *para*-, *meta*-, *meta*-; (4) *para*-, *para*-, *para*-, *meta*-, *meta*-, *meta*-; (5) *para*-, *para*-, *meta*-, *meta*-, *meta*-, *meta*-; (6) *para*-, *meta*-, *meta*-, *meta*-, *meta*-, *meta*-; and (7) *meta*-, *meta*-, *meta*-, *meta*-, *meta*-, *meta*-.

Please replace the third paragraph on page 47, lines 9-23 with the following amended paragraph:

Preferably, the porogen is bonded to the thermosetting component through an ethynyl containing group. In one embodiment, the ethynyl containing group is first reacted with the porogen as shown in Figures 5, 7, 9, and 11. In a preferred embodiment, the ethynyl containing group is first reacted with the thermosetting component as shown in Figures 4, 6, 8, and 10. In Figures 4 through 11, although only 1,3/4-bis[1',3',5'-tris(3''/4''-bromophenyl)adamant-7'-yl]benzene is ~~shown~~ described, it is understood that similar reaction occur for other useful thermosetting components including 1,3,5,7-tetrakis(3'/4'-bromophenyl)adamantane and 1,3-bis{3'/4'-[1'',3'',5''-tris(3'''/4'''-bromophenyl)adamant-7''-yl]phenyl}-5,7-bis{3'''/4'''-bromophenyl}adamantane. Useful ethynyl containing groups include fluorine; amine; or hydroxy; and preferably, are acetylene; 4-ethynylaniline; 3-hydroxyphenylacetylene; 4-fluorophenylacetylene; and 1-ethylcyclohexylamine. Preferably, a covalent bond forms between the porogen and the thermosetting component through the ethynyl containing group.

Please replace the second full paragraph on page 66, lines 19-24 with the following amended paragraph:

Step (a): Preparation of Mixture of
1,3,5,7-tetrakis(3'/4'-bromophenyl)adamantane (~~shown in Figure 1A~~);
1,3/4-bis[1',3',5'-tris(3''/4''-bromophenyl)adamant-7'-yl]benzene (~~shown in Figure 1C~~); and at least
1,3-bis{3'/4'-[1'',3'',5''-tris(3'''/4'''-bromophenyl)adamant-7''-yl]phenyl}-5,7-bis(3'''/4'''-
bromophenyl)adamantane (~~shown in Figure 1C~~) (collectively "P1 Step (a) Product")

Please replace the third, fourth and fifth paragraphs on page 67, lines 8-33 and page 68, lines 1-2 with the following amended paragraphs:

A third reaction vessel was loaded with 20.4 liters of petroleum ether (mainly isooctane with a boiling range of 80°C-110°C). The contents of the second reaction vessel were slowly added over a period of one hour to the third reaction vessel. The resulting mixture was stirred for at least one hour. The precipitate was filtered off and the filter cake was washed twice with 300 milliliters per wash of the aforementioned petroleum ether. The washed filter cake was dried overnight at 45°C at 40mbar. The P1 Step (a) Product yield was 407 grams dry weight. ~~This reaction is shown in Figures 1A through 1C as follows. Figure 1A shows the resulting monomer. Figure 1B shows the resulting generic dimer and higher products while Figure 1C shows the resulting specific dimer and trimer covered by the Figure 1B structure.~~

Analytical techniques including GPC, HPLC, and NMR were used to identify the product. GPC analysis showed: 1,3,5,7-tetrakis(3'/4'-bromophenyl)adamantane (~~shown in Figure 1A~~) had a peak molecular weight of 430; 1,3/4-bis[1',3',5'-tris(3''/4''-bromophenyl)adamant-7'-yl]benzene (~~shown in Figure 1C~~) had a peak molecular weight of 820; 1,3-bis{3'/4'-[1'',3'',5''-tris(3'''/4'''-bromophenyl)adamant-7''-yl]phenyl}-5,7-bis(3'''/4'''-bromophenyl)adamantane (shown in Figure 1C) had a peak molecular weight of about 1150 (shoulder).

Step (b): Preparation of Mixture of

1,3,5,7-tetrakis[3',4'-(phenylethynyl)phenyl]adamantane (~~shown in Figure 1D~~); 1,3/4-bis{1',3',5'-tris[3''/4''-(phenylethynyl)phenyl]adamant-7'-yl} benzene (~~shown in Figure 1F~~); and at least 1,3-bis{3'/4'-[1'',3'',5''-tris[3'''/4'''-(phenylethynyl)phenyl]adamant-7''-yl]phenyl}-5,7-bis[3'''/4'''-(phenylethynyl)phenyl]adamantane (~~shown in Figure 1F~~) (collectively "P1 Step (b) Product")

Please replace the second and third paragraphs on page 69, lines 9-28 with the following amended paragraphs:

A second reactor was loaded with 17000 milliliters of petroleum ether (mainly isooctane with a boiling range of 80°C-110°C). The contents of the first reactor were added over a period of one hour to the second reactor and stirred overnight. The precipitate was filtered and washed four times with 500 milliliters per wash of the aforescribed petroleum ether. The product was dried under reduced pressure for four hours at 45°C and five hours at 80°C. The P1 Step (B) Product yield was 850-900 grams. ~~This reaction is shown in Figures 1D through 1F as follows. Figure 1D shows the resulting monomer. Figure 1E shows the resulting generic dimer and higher products while Figure 1F shows the resulting specific dimer and trimer covered by the Figure 1F structure.~~

Analytical techniques including GPC, HPLC, NMR, and FTIR were used to identify the product. GPC analysis showed: 1,3,5,7-tetrakis[3',4'-(phenylethynyl)phenyl]adamantane ~~(shown in Figure 1D)~~ had a peak molecular weight of about 900; 1,3/4-bis{1',3',5'-tris[3''/4''-(phenylethynyl)phenyl]adamant-7'-yl} benzene ~~(shown in Figure 1F)~~ had a peak molecular weight of about 1500; 1,3-bis{3'/4'-[1'',3'',5''-tris[3'''/4'''-(phenylethynyl)phenyl]adamant-7''-yl]phenyl}-5,7-bis[3'''/4'''-(phenylethynyl)phenyl]adamantane ~~(shown in Figure 1F)~~ had a peak molecular weight of about 2100 (shoulder).

Please replace the last paragraph on page 70, lines 20-26 with the following amended paragraph:

Step (a): Preparation of Mixture of
1,3,5,7-tetrakis(3'/4'-bromophenyl)adamantane (~~shown in Figure 1A~~);
1,3/4-bis[1',3',5'-tris(3''/4''-bromophenyl)adamant-7'-yl] benzene (~~shown in Figure 1C~~); and at
least 1,3-bis{3'/4'-[1'',3'',5''-tris(3'''/4'''-bromophenyl)adamant-7''-yl]phenyl}-5,7-bis(3'''/4'''-
bromophenyl)adamantane(~~shown in Figure 1C~~)(collectively "P2 Step (a) Product")

Please replace the last paragraph on page 71, lines 25-32 with the following amended paragraph:

Analytical techniques including GPC, HPLC, and NMR were used to identify the product. GPC analysis showed: 1,3,5,7-tetrakis(3'/4'-bromophenyl)adamantane (~~shown in Figure 1A~~) had a peak molecular weight of about 430; 1,3/4-bis[1',3',5'-tris(3''/4''-bromophenyl)adamant-7'-yl] benzene (~~shown in Figure 1C~~) had a peak molecular weight of about 820; 1,3-bis{3'/4'-[1'',3'',5''-tris(3'''/4'''-bromophenyl)adamant-7''-yl]phenyl}-5,7-bis(3'''/4'''-bromophenyl)adamantane (~~shown in Figure 1C~~) had a peak molecular weight of about 1150 (shoulder).

Please replace the first paragraph on page 72, lines 1-8 with the following amended paragraph:

Step (b): Preparation of Mixture of
1,3,5,7-tetrakis[3',4'-(phenylethynyl)phenyl]adamantane (~~shown in Figure 1D~~); 1,3/4-bis{1',3',5'-tris[3''/4''-(phenylethynyl)phenyl]adamant-7'-yl}benzene (~~shown in Figure 1F~~); and at least 1,3-bis{3'/4'-[1'',3'',5''-tris[3'''/4'''-(phenylethynyl)phenyl]adamant-7''-yl]phenyl}-5,7-bis[3'''/4'''-(phenylethynyl)phenyl]adamantane (~~shown in Figure 1F~~)(collectively "P2 Step (b) Product")

Please replace the last paragraph on page 73, lines 23-31 with the following amended paragraph:

Analytical techniques including GPC, HPLC, and NMR were used to identify the product. GPC analysis showed: 1,3,5,7-tetrakis[3',4'-(phenylethynyl)phenyl]adamantane (~~shown in Figure 1D~~) had a peak molecular weight of about 900; 1,3/4-bis{1',3',5'-tris[3''/4''-(phenylethynyl)phenyl]adamant-7'-yl} benzene (~~shown in Figure 1F~~) had a peak molecular weight of about 1500; 1,3-bis{3'/4'-[1'',3'',5''-tris[3'''/4'''-(phenylethynyl)phenyl]adamant-7''-yl]phenyl}-5,7-bis[3'''/4'''-(phenylethynyl)phenyl]adamantane (~~shown in Figure 1F~~) had a peak molecular weight of about 2100 (shoulder).

Please replace the last paragraph on page 74, lines 21-26 with the following amended paragraph:

Impact of Solvent on ratio of 1,3,5,7-tetrakis[3',4'-(phenylethynyl)phenyl]adamantane (~~shown in Figure 1D~~) to 1,3/4-bis{1',3',5'-tris[3''/4''-phenylethynyl]phenyl}adamant-7'-yl} benzene (~~shown in Figure 1F~~) and at least 1,3-bis{3'/4'-[1'',3'',5''-tris[3'''/4'''-(phenylethynyl)phenyl]adamant-7''-yl]phenyl}-5,7-bis[3''''/4''''-(phenylethynyl)phenyl]adamantane (~~shown in Figure 1F~~).

Please replace the last paragraph on page 75, lines 14-21 with the following amended paragraph:

Reaction mixtures were analyzed by GPC during the reaction and before precipitation. All filtrates and final solids were analyzed by GPC and the results are in Table 4. In Table 4, PPT stands for precipitation, monomer is 1,3,5,7-tetrakis(3'/4'-bromophenyl)adamantane (~~shown in Figure 1A~~); dimer is 1,3/4-bis[1',3',5'-tris(3''/4''-bromophenyl)adamant-7'-yl]benzene (~~shown in Figure 1C~~); and trimer is 1,3-bis{3'/4'-[1'',3'',5''-tris(3'''/4'''-bromophenyl)adamant-7''-yl]phenyl}-5,7-bis(3''''/4''''-bromophenyl)adamantane (~~shown in Figure 1C~~).

Please replace the second, third and fourth paragraphs on page 76, lines 8-31 with the following amended paragraphs:

Preparation 4 – Preparation of Thermosetting Component

The 1,3/4-bis{1',3',5'-tris[3''/4''-(phenylethynyl)phenyl]adamant-7'-yl} benzene (~~shown in Figure 1F~~) in the Preparation 1 product mixture is separated using preparative liquid chromatography (PLC). PLC is similar to the HPLC method described above but uses larger columns to separate larger quantities of the mixture (from several grams to several hundred grams).

Preparation 5 – Preparation of Thermosetting Component

The 1,3-bis{3'/4'-[1'',3'',5''-tris[3'''/4'''-(phenylethynyl)phenyl]adamant-7''-yl]phenyl}-5,7-bis[3'''/4'''-(phenylethynyl) phenyl]adamantane (~~shown in Figure 1F~~) in the Preparation 1 product mixture is separated using preparative liquid chromatography (PLC).

Preparation 6 – Preparation of Thermosetting Component

The diamantane monomer of Formula V and oligomer or polymer of diamantane monomer of Formulae VI, VIII, X, XII, XV, XVI, and XVIII are prepared using the following method. ~~As shown in Figure 2, diamantane~~ Diamantane is converted using bromine and a Lewis Acid catalyst to brominated diamantane product. The brominated diamantane product is then reacted with bromobenzene in the presence of a Lewis Acid catalyst to form bromophenylated diamantane. The bromophenylated diamantane is then reacted with a terminal alkyne in the presence of a catalyst system as used in the so-called Sonogashira coupling reaction. The product at each step is worked up as described in our pending patent application PCT/US01/22204 filed October 17, 2001.

Please replace the first paragraph on page 77, lines 7-19 with the following amended paragraph:

The diamantane monomer of Formula V and oligomer or polymer of diamantane monomer of Formulae VI, VIII, X, XII, XV, XVI, and XVIII are prepared using the following method. ~~As shown in Figures 1A through 1F, diamantane~~ Diamantane is converted to the bromophenylated compositions of diamantane using similar synthetic procedures as described in Preparations 1 and 2. ~~In Figures 1A through 1C, diamantane~~ Diamantane is reacted with a substituted halogen phenyl compound in the presence of a Lewis Acid catalyst as described in Preparations 1 and 2, and/or a second catalyst component as described in Preparation 2. A mixture of monomers, dimers, trimers, and higher oligomers is obtained after work-up of the reaction mixtures. ~~In Figures 1D through 1F,~~ ~~the~~ The bromophenylated diamantane mixture is then reacted with a terminal alkyne in the presence of catalyst to produce the alkyne-substituted diamantane compositions of the present invention.

Please replace the second full paragraph on page 79, lines 10-19 with the following amended paragraph:

The composition was applied to a substrate using typical coating conditions known to those skilled in the art. The resulting spun-on composition was baked for one minute under N₂ (< 50 ppm O₂) at each of the following temperatures: 125°C, 250°C, and 300°C. The furnace cure condition was 400°C for 60 minutes in N₂ (26 liters/minute) with ramping up from 250°C at 5°K per minute. The cure temperature range was from 350°C to 450°C. In each composition, the porogen decomposed and the decomposed porogen volatilized whereby pores formed in the composition. The layer had a refractive index of 1.433 and a thickness of 2414 Angstroms. ~~Figure 13 shows the Scanning Electronic Microscope results.~~

Please replace the last paragraph on page 80, lines 20-31 and page 81, lines 1-6 with the following amended paragraph:

The reaction mixture was cooled to room temperature and transferred to a 1 liter, 3 neck flask equipped with a condenser, a mechanical stirrer and a nitrogen inlet-outlet and toluene (amount=100 milliliters) was added. The solution was then neutralized with 6N HCl. The resulting water was removed. The toluene solution was then stirred with 100 mL of 6N HCl at 60 °C for 30 min. The mixture was filtered through ~~eelite~~ CELITE® naturally occurring inorganic material. The aqueous solution was then removed. The HCl extraction was repeated for two more times. The toluene solution was then washed with 100 mL of deionized water twice. The solution was stirred with 100 mL of 0.1 M of N-acetyl-cysteine in ammonia solution at 60 °C for 30 min. The aqueous solution was then removed. The ammonia extraction was repeated for five more times. The toluene was then removed by rotary evaporator and the resulting solid was dried under vacuum overnight. The preceding reaction scheme ~~is shown in Figure 14 where although only~~ describes 1,3/4-bis[1',3',5'-tris(3''/4''-bromophenyl)adamant-7'-yl]benzene ~~is shown, but~~ it is understood that similar reactions occur for 1,3,5,7-tetrakis(3'/4'-bromophenyl)adamantane and 1,3-bis{3'/4'-[1'',3'',5''-tris(3'''/4'''-bromophenyl)adamant-7''-yl]phenyl}-5,7-bis{3'''/4'''-bromophenyl}adamantane.

Please replace the second full paragraph on page 81, lines 13-23 with the following amended paragraph:

The composition was applied to a substrate using typical coating conditions known to those skilled in the art. The resulting spun-on composition was baked for one minute under N₂ (< 50 ppm O₂) at each of the following temperatures: 125°C, 250°C, and 300°C. The furnace cure condition was 400°C for 60 minutes in N₂ (26 liters/minute) with ramping up from 250°C at 5°K per minute. The cure temperature range was from 350°C to 450°C. In each composition, the porogen decomposed and the decomposed porogen volatilized whereby pores formed in the composition. After bake, the layer had a refractive index of 1.636 and a thickness of 1255 Angstroms. After cure, the layer had a refractive index of 1.398 and a thickness of 1056 Angstroms. ~~Figure 15 shows Scanning Electron Microscope results.~~

Please replace the last paragraph on page 82, lines 28-32 and page 83, lines 1-13 with the following amended paragraph:

The reaction mixture was cooled to room temperature and transferred to a 1 liter, 3 neck flask equipped with a condenser, a mechanical stirrer and a nitrogen inlet-outlet and toluene (amount=100 milliliters) was added. The solution was then neutralized with 6N HCl. The resulting water was removed. The toluene solution was then stirred with 100 mL of 6N HCl at 60 °C for 30 min. The mixture was filtered through celite®. The aqueous solution was then removed. The HCl extraction was repeated for two more times. The toluene solution was then washed with 100 mL of deionized water twice. The solution was stirred with 100 mL of 0.1 M of N-acetyl-cysteine in ammonia solution at 60 °C for 30 min. The aqueous solution was then removed. The ammonia extraction was repeated for five more times. The toluene was then removed by rotary evaporator and the resulting solid was dried under vacuum overnight. The preceding reaction scheme ~~is shown in Figure 16 where although only describes~~ 1,3/4-bis[1',3',5'-tris(3''/4''-bromophenyl)adamant-7'-yl]benzene ~~is shown,~~ but it is understood that similar reactions occur for 1,3,5,7-tetrakis(3'/4'-bromophenyl)adamantane and 1,3-bis{3'/4'-[1'',3'',5''-tris(3'''/4'''-bromophenyl)adamant-7''-yl]phenyl}-5,7-bis{3''''/4''''-bromophenyl}adamantane.